Aircraft Operations & Climate Change

Student A

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Climate Change

- Caused by release of Carbon Dioxide (CO₂) and other Greenhouse Gases (GHG) into the atmosphere
- Kyoto Protocol and Paris Agreement
 - Set limits for countries to restrict emissions of Greenhouse Gases
 - Do not apply to aviation (Agarwal, R., Collier, F., Schaefer, A., & Seabridge, A. (Eds.). 2016)



Retrieved from www.scienceabc.com

Increased CO₂Levels



Retrieved from:

https://www.theglobaleducationproject.org/climate-change/

Types of Pollution

- Carbon Dioxide(CO₂)
- Carbon Monoxide (CO)
- Nitrogen Oxides (No_x)
- Particulate Matter (PM)
 - Primary PM Dust, Soot, Smoke, Water droplets
 - Secondary PM Sulfur Dioxide (SO₂), Unburned Hydrocarbons
- (Belobaba, P., Odoni, A., & Barnhart, C., 2015)



Retrieved from: https://jalopnik.com/why-were-oldjet-engines-so-much-more-smokeythan-newer-1720531271

Nitrogen Oxides and Ozone

- NO_x from aircraft is 4.35 times more efficient at producing Ozone than road transport
 - (Hauglustaine, D., & Koffi, B., 2012)
- Ozone
 - In the troposphere causes health problems by damaging lung tissue
 - In the stratosphere protects us from UV rays
- These types of pollution contribute to smog and cause breathing issues
- (Significance, O. I. T. O. A., & National, R. C. S., 2010)

Pollution from Aircraft

- Aircraft currently contribute 3.2% of GHG emissions in the US.
 - Only 2 to 2.5% worldwide (National, A. O. S. E. A., Division, O. E. A. P. S., Aeronautics, A. S. E. B., & Committee, O. P. A. E. S., 2016).
 - Higher in the US because it is more advanced and reliant on air travel.



Retrieved from: https://www.economist.com/specialreport/2006/06/08/the-skys-the-limit

Growth of Aviation Emissions



- China has one fifth of the domestic aviation as the US but is growing at 10% per year
- Other Asian countries growing at 6%
- Demand worldwide has been steadily growing since the recession in 2008
- (Agarwal, R., Collier, F., Schaefer, A., & Seabridge, A. (Eds.)., 2016)

Retrieved from: https://ebookcentral.proquest.com/lib/wilmcollebooks/reader.action?docID=4694617

Popularity of Air Travel

- 53% of international travelers arrive away from home by aircraft
 - 40% by road
 - 5% by water
 - 2% by rail
- 35% of goods traded internationally travel by air
- (Agarwal, R., Collier, F., Schaefer, A., & Seabridge, A. (Eds.)., 2016)



Retreived from: https://www.philly.com/philly/busines s/transportation/20160419_Get_read y_for_long_airport_security_lines_this_ summer.html

Increase of Global Aircraft Fuel Burn



Source: International Civil Aviation Organization, ICAO Environmental Report 2010

Retrieved from:

https://jherrerosdc.typepad.com/.a/6a010535d08325970 c0162fc0590f7970d-pi

- Fuel burnt directly correlates to pollutants emitted
- Different colors depict improved technology or operational improvement
- Even with improvements, we will see a significant increase

CO₂ Output

- Aircraft are far less efficient per passenger than other forms of transportation
- Train is clearly the least polluting way to travel

grams of CO 14 per passanger 55 kilometre 68 72 104 158 285 vehicle and number 300 250 200 150 100 50 of passangers

Nose: The figures have been estimated with an average number of passengers per vehicle. The addition of more passengers results in fuel consumption - and hence also CO2 emissions - penalty as the vehicle becomes heavier, but the final figure in grams of CO2 per passenger is obviously lower. Infand ship emission factor is estimated to be 245 gCO2/pkm but data availability is still not comparable to that of other models. Estimations based on TRACCS database, 2013 and TRM027 indicator.

> Retrieved from: http://www.bitsofscience.org/plane-ortrain-planes-20x-as-bad-climate-per-km-6835/

Source: EEA report TERM 2014

eea.europa.eu/transport

Solutions

Alternative Fuels

- Sustainable Jet Fuel
 - Developed from natural oils, animal fat, sugarcane, agricultural residues, waste oils, wood biomass, and microalgae
 - No large-scale operations yet
 - Testing is promising but widescale use in the near future is unlikely
- (Wormslev, E. C., Pedersen, J. L., & Eriksen, C., 2016)



Retrieved from:

https://cleantechnica.com/2011/08/09/braziliancompanies-study-feasibility-of-renewable-jet-fuelfrom-sugar-cane/

Engine Technology

- Gas turbine advances
 - 30% estimated improvement possible
- Turboelectric Propulsion
 - Still needs significant improvements
 - Currently no proper simulation for testing
- Past advances have been for quieter engines which are less efficient
- (National, A. O. S. E. A., Division, O. E. A. P. S., Aeronautics, A. S. E. B., & Committee, O. P. A. E. S., 2016).



Retrieved from: http://sustainableskies.org/rolls-royceairbus-and-siemens-team-up-on-hybrid-airliner

Airframe Technology



Retrieved from: https://wordlesstech.com/hybrid-wingbody-by-lockheed-martin/

- Hybrid Wing Technology
 - Lighter weight
 - Higher lift to drag ratio
 - Better fuel efficiency
 - Many structural challenges
- (Agarwal, R., Collier, F., Schaefer, A., & Seabridge, A. (Eds.)., 2016)

New Technology Implementation

- It takes 40 years to turn over an airline fleet to new technology
 - Due to initial cost and lifespan
- (Belobaba, P., Odoni, A., & Barnhart, C., 2015)



Retrieved from: http://www.mikeszone.com/mikes-dc-3/



https://www.thenorthwestern.com/story/news/loc al/oshkosh/airventure/2015/07/16/airbus-a350xwb-debuts-airventure/30241007/

Legislation

- Environmental Protection Agency Regulations
 - Air has gotten steadily cleaner in the US since the 1970's
 - Don't apply to aircraft
 - Industries and vehicles are getting cleaner
 - Increased percentage of aircraft emissions in relation to others
- International Civil Aviation Organization
 - Does not have stringent emissions standards
 - Very difficult to measure emissions of aircraft
- (Belobaba, P., Odoni, A., & Barnhart, C., 2015)



Retrieved from: https://www.canso.org/aviationunites-cyber-threat

Immediate Impacts

- Optimized Profile Descents
 - Better engine efficiency at higher altitudes
 - Delay descent as long as possible
 - Descend at idle power

- Single Engine Taxi
 - More fuel efficient since less thrust is needed on the ground
 - Especially important at large airports with a long taxi time and delay before takeoff
- Airline scheduling
- Refrain from scheduling all aircraft at the same time
- More efficient use of airspace and runways
- Less holding and fuel burn
- (Belobaba, P., Odoni, A., & Barnhart, C., 2015)

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